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ABSTRACT

Interactive multimedia (IMM) and problem-based learning (PBL) are both promoted in response to the current need to offer authentic and effective professional education. An emphasis on collaborative work in PBL contexts may have discouraged the application of IMM, more commonly designed for individual use. This paper describes preliminary instructional design model for IMM using PBL principles and includes approaches to resolving the apparent tensions between the two methodologies. Application of this model to development of a CD-ROM for teacher education is described. Topics discussed include: (1) an introduction to PBL, including instructional design and computer support of PBL; (2) IMM-PBL design issues, including collaboration versus individual learning, free exploration versus storylines and simulated reality, and tutors versus scaffolding; (3) a design model for IMM-PBL, including scenario development and structure; and (4) applying the IMM-PBL instructional design model, including scenario development, scenario structure, navigation and visual format, and production and evaluation. Two figures illustrate the IMM-PBL scenario development, and the IMM-PBL scenario structure. (Author/DLS)

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Interactive Multimedia and Problem-Based Learning: Challenges for Instructional Design

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Abstract: Interactive multimedia (IMM) and problem-based learning (PBL) are both promoted in response to the current need to offer authentic and effective professional education. An emphasis on collaborative work in PBL contexts may have discouraged the application of IMM, more commonly designed for individual use. This paper describes a preliminary instructional design model for IMM using PBL principles and includes approaches to resolving the apparent tensions between the two methodologies. Application of this model to development of a CD-ROM for teacher education is described.

1. Introduction and Background

Traditional approaches to university education promote subject-based learning which encourages teachers to focus on covering material and students to adopt surface learning which fails to integrate knowledge [Margetson 1994]. New approaches encouraging both the integration of existing knowledge and the habits and skills fundamental to lifelong learning are needed. In addition, a need for periodic professional development and the desire of some to explore new careers, have contributed to demand for more flexible access to higher education. Coincidentally, new technologies promise to facilitate access to learning at times and places chosen by the learner.

Problem-based learning (PBL) developed in response to concerns that a subject based approach might not be the most effective preparation for future professionals [Boud 1985]. Since originating in North American medical schools, PBL has spread to many countries and a variety of fields including nursing, engineering, law and business [Boud and Feletti 1991]. Its characteristic focus on authentic problems as the starting point for learning has been credited with increasing the motivation of students and encouraging them to integrate knowledge from foundation disciplines. If it is true that PBL offers advantages for professional education and there is demonstrable demand for flexible access to such educational programs, then it seems logical to consider the use of interactive multi-media (IMM), as a means of making the benefits of PBL more widely available.

1.1 Instructional Design for PBL

The first step towards incorporating PBL principles into the instructional design and development of interactive multimedia resources is to identify the essential characteristics of PBL. Two commonly cited descriptions of PBL come from Boud (1985) and Bridges (1992). In outlining their views of PBL, these authors agree that the focus in a PBL process is on an authentic problem in a group setting where learning stems from collaborative analysis of the problem and is largely learner-directed. An alternative approach in

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which teacher education students engaged with a problem individually and prepared a written analysis of the problem in preparation for group interaction, has also been described [Gibson and Gibson, 1995]. Further, the collaboration of students in small groups has been an explicit assumption underlying the development of computer environments supporting PBL [Ronteltap and Eurelings 1997] [Koschmann et al. 1996]. Regardless of author however, each description of PBL incorporates reference to an authentic problem as the initial focus and assigns active, group-based roles to learners, at some stage of the process, for the purpose of determining solutions and synthesising knowledge.

Moreover, Heath [Heath 1997] recognises a trend in instructional design towards replacing traditional behaviourist approaches with constructivist orientations emphasising the use of emerging technologies. By incorporating interaction with an environment, cognitive conflict and negotiation of shared understanding, PBL provides an ideal vehicle for modelling such constructivist approaches [Savery and Duffy 1995].

1.2 Computer Support of PBL

A variety of examples of computer use in PBL programs can be found in the literature. A "Problem Solving Assistant", incorporating a problem-solving heuristic and research resources has been used to support teacher education students [Ritchie et al. 1995]. [Hart 1996] described a PBL architectural course using computer graphics systems. Computers have been linked to create a Collaborative Learning Laboratory [Koschmann et al. 1996] to support PBL meetings in medical education through access to resources and data exchange. Network technologies, including web pages, have supported collaborative PBL in a biotechnology program [Mackenzie et al. 1997], and a dual electronic environment which supports access to resources and preparation for subsequent group presentation in a collaborative environment has also been described [Ronteltap and Eurelings 1997].

Despite the emergence of computer use in professional courses incorporating PBL, [Hoffman and Ritchie 1997] found no published articles about integration of interactive multimedia in PBL. They suggested that multimedia might support PBL by producing key benefits in fidelity, representational richness, time and timeliness, individualisation, assessment, efficiency and increased power of agency.

2. Issues in the Design of IMM-PBL

2.1 Collaboration versus Individual Learning

Implementations of PBL typically include collaborative group work. Whether such collaboration is an essential component of PBL logically depends upon the role it plays in the overall experience of PBL. On the other hand, interactive multimedia is typically designed for individual use.

Exploring the value of PBL experiences for individual rather than collaborative use may be justified on two grounds. Firstly, professional practice is situated in a variety of contexts including collaborative teams, sole practice and competition. Successful professional practice frequently depends upon individual capacity to solve problems. Logically, educational experiences which develop that capacity should be valued. Secondly, individual PBL experiences may help to address the increasing interest in distance and flexible access to professional education and the increasingly successful integration of technology into higher education.

Studies of the cognitive and metacognitive processes of students during the initial problem analysis phase of PBL support the view that the role of group interactions in PBL is to facilitate activation and elaboration of students' existing knowledge and so encourage conceptual change through cognitive dissonance [De Grave et al. 1996]. If this is the function of group interaction in PBL, then, provided that an alternative mechanism with equivalent effect is introduced, it should be possible to design effective PBL for individual use.

2.2 Free Exploration versus Storylines and Simulated Reality

One of the characteristics of multimedia as an information source is ease of access. Users of multimedia expect to be able to explore the environment encountering a variety of stimuli. A key characteristic of PBL is its use of authentic problems. In real life, resources may sometimes be inaccessible, activities may be time dependent and decisions may be effectively irreversible. These conditions occur in the simulated reality of computer games.

Multimedia materials supporting individual PBL will include problem scenarios sharing some characteristics of computer games alongside collections of resources to be explored in the search for a solution. It seems likely that there will be tension between the genre of the computer game and that of the multimedia encyclopedia with the possibility of confusion for users. The efficacy of story for motivating progress through multimedia training and increasing transfer of content has been demonstrated [Bielenberg and Carpenter-Smith 1996]. Building a storyline around a problem may assist in drawing the user out of exploration mode, into and through the problem.

2.3 Tutors versus Scaffolding

Tutors in PBL groups do not act as informants but as facilitators who model higher order thinking and challenge the thinking of learners [Boud 1985]. The use of scaffolding approaches, such as breaking the larger problem into sub-problems [Savery and Duffy 1995] or including heuristic aids [Ritchie et al. 1995], may be appropriate alternatives for individual PBL using multimedia materials.

3. A Design Model for IMM-PBL

3.1 Scenario Development

[Fig. 1] outlines the process of developing a problem scenario for IMM-PBL. Although the model was refined in the process of developing an IMM-PBL package for teacher education, it is presented here in general form.

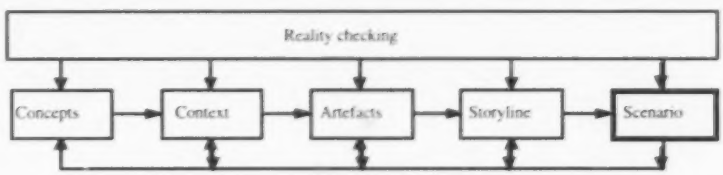

Figure 1: IMM-PBL scenario development

Development begins with identification of key concepts from the content domain [Savery and Duffy 1995] and a typical context in which the concepts might be used. A description of the context including aspects of the environment and the problem is developed. The problem is divided into a series of sub-problems to facilitate scaffolding by considering the types of artefacts, typically documents of various kinds, which might be produced in association with a stepwise solution to the problem situation. Finally, the scenario is completed by devising a storyline which describes the progress of the problem solver from initial encounter with the problem to final resolution and provides the motivation for the user. At each stage, effort is devoted to applying reality checks to ensure that the overall scenario, and each element of it, is plausible, and flows naturally according to user choice. The process tends to be iterative rather than linear and, as indicated in the lower portion of the figure, there is a feedback loop through which evaluations at each stage can influence subsequent revisions.

3.2 Scenario Structure

[Fig. 2] illustrates the structure of a typical problem scenario for IMM-PBL. Again the model has been generalised to highlight the principles of the instructional design.

In order to assist the learner through metacognitive scaffolding, the problem scenario is presented as a series of tasks embedded in a storyline related to a professional context. Each task results in preparation of some artefact relevant to the problem. The Activation Task is intended to situate the learner in the problem context and to begin the process of activating relevant prior knowledge. Elaboration Tasks provide opportunity for recall and reconfiguration of prior knowledge relevant to the specific problem and exploration of additional, context specific knowledge and 'experience' gained during problem solution. Consolidation Tasks emphasise relevant knowledge transfer, analysis, integration, synthesis and evaluation of selected, context specific knowledge and problem based 'experience'. Finally, the reflection task is designed to encourage learners to further integrate knowledge, 'experience' and artefacts gathered through the problem solving process into their cognitive structures as though products of real experience.

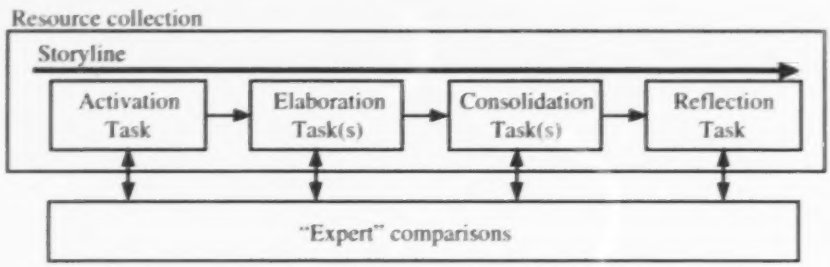

Figure 2: IMM-PBL scenario structure

After each task, users are able to compare their artefact with examples from a panel of experts. These interactions with experienced professionals replace the interactions with peers [De Grave et al. 1996] or with a facilitator [Savery and Duffy 1995]. Except when the storyline requires otherwise, users have access to a collection of resources relevant to the concepts encapsulated in the problems. Because PBL is intended to increase the capacity of learners to solve real problems [Boud 1985] and because identifying critical elements may be counter-productive [Savery and Duffy 1995], the selection of resources for inclusion in the package is gauged to require judgement in selection from what is provided and initiative in employing material from alternative sources.

4. Applying the IMM-PBL Instructional Design Model

The IMM-PBL instructional design model emerged during the development of a CD-ROM package to assist teachers with technology integration [Gibson and Albion, 1998]. The CD-ROM includes a collection of resources relevant to the use of technology in classroom teaching and a series of four problem scenarios based around the common theme of integrating technology into a variety of teaching contexts. Development of one problem scenario will be described as an example of how the design model may be applied.

4.1 Scenario Development

As it was desirable across the intended set of scenarios to represent different teaching circumstances in terms of school setting, pupil characteristics and resource availability, the overall context for the problems was developed around the situation of a teacher applying for a series of short term appointments. For this problem the specific context selected was a small rural school with multi-aged classrooms. The particular class to which the user would be assigned was about to be equipped with a new computer.

Concepts identified for inclusion within this scenario centred around planning and management issues associated with the integration of a single computer into a classroom, including the physical location of resources; planning for individual, small group and whole class work with computers; and behaviour management.

Artefacts identified as appropriate to this context included a brief statement about technology integration, a floorplan showing placement of furnishings and a powersource, notes about planning for technology use for discussion with other staff members and a summary of presentations from staff members in a staff meeting. Using these artefacts as a foundation, a simple storyline was sketched, and embellished with a non-reversible decision point (a chance to visit another classroom via video clips), a tour of the school with the Principal [voice over] and opportunities to interview other teachers (via video).

Checks on content validity, logic flow, professional plausibility and product feasibility were conducted at appropriate stages during the design and development process using a panel of experienced teachers, a cohort of pre-service teacher education students and professional colleagues from several international universities.

4.2 Scenario Structure

Since the overall context of the problem scenarios was devised around the search for temporary employment, the activation task in this problem comprised a brief response to a selection criterion relevant to the technology concepts embedded in the scenario. Planning the arrangement of classroom furnishings using a manipulative graphic floor plan afforded additional opportunity for elaboration of relevant knowledge through a concrete task and represented the elaboration task for this problem.

Work on consolidation tasks, presented as preparation for a staff discussion and supported by outlines provided in the software, required students to access other resources and to structure their own thoughts on the topic. Finally the reflection task offered an opportunity to reconsider the problem and to synthesise personal responses with the samples provided in the materials. Expert comparisons were provided in the form of sample solutions prepared by a panel of experienced teachers. These were made available to learners following completion of each task.

Resources provided on the CD-ROM included documents specific to the problem (school policies and plans), as well as a collection of more general material including video segments illustrating classroom computer use, relevant policy documents from education authorities and additional materials describing computer integration.

4.3 Navigation and Visual Format

Interactive packages of this type require a consistent format for visual display. Further, a means of navigation through the problem which provided intuitive control to the user was a necessity if the impact of the message was not to be subjugated to lower order issues of screen or movement control. In this package, an integral component of the teaching environment, the teacher's desk, provided a natural navigational tool for users. It was from this desk that all action and decision points, governing progress through the problem, originated.

4.4 Production and evaluation

The complexity of multimedia production typically requires that it be accomplished by a team with a variety of skills rather than through the efforts of one or two individuals. The production process for the package described in this paper has been outlined elsewhere [Gibson and Albion, 1997]. Integral to complicated processes of this type is the need for an evaluation strategy capable of supporting development. The formative

evaluation of an early prototype of this package was carried out with a group of final year teacher education students. Reactions to the presentation and content of the first scenario have improved the useability of the final product. More extensive evaluations will be conducted with the final product. An area of particular interest in future evaluations will be the capacity of this CD-ROM based, interactive multimedia problem-based learning package to induce effects similar to those obtained with traditional approaches to PBL.

5. Conclusion

In combining the recognised strengths of problem based learning and interactive multimedia, issues related to the instructional design of such products became central to the development process. In describing some of these challenges to instructional design, the authors have recognised the difficulties inherent in attempting to translate a traditional, group based approach to learning, into a technology mediated, individual experience. Early indications from sample target group evaluations and analyses from professional colleagues in a variety of international contexts indicate that the effort has a credible foundation.

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